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ADDRESS

OF

DR. JOHN L. LeCONTE,

THE RETIRING PRESIDENT OF THE ASSOCIATION.

GENTLEMEN AND LADIES OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE:—

THE founders of science in America, and the other great students of nature, who have in previous years occupied the elevated position in which I now stand, have addressed you upon many momentous subjects. In fulfilling the final duty, assigned to your Presidents by the laws of the Association, some have spoken to you in solemn and wise words concerning the duties and privileges of men of science: and the converse duties of the nation towards those earnest and disinterested promoters of knowledge. Others again have given you the history of the development of their respective branches of study, and their present condition, and have, in eloquent diction, commended to your gratitude those who have established on a firm foundation the basis of our modern systems of investigation.

The recent changes in our Constitution, by which you are led to expect from your two Vice-presidents, and from the Chairman of the Chemical Subsection, addresses on the progress made during the past year, restrain me from invading their peculiar fields of

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labor, by alluding to scientific work which has been accomplished since our last meeting. While delicacy forbids me from so doing, I am equally debarred from repeating to you the brief sketch I endeavored to give at a former meeting[1] of the history, and present condition of Entomology in the United States.

But it has appeared to me that a few thoughts, which have impressed themselves on my mind, touching the future results to be obtained from certain classes of facts, not yet fully developed, on account of the great labor required for their proper comparison, may not be without value. Even if the facts be not new to you, I hope to be able, with your kind attention, to present them in such way as to be suggestive of the work yet to be done.

It has been perhaps said, or at least it has been often thought, that the first mention of the doctrine of evolution, as now admitted to a greater or less degree by every thinking man, is found in Ecclesiastes, i, 9 :—

"The thing that hath been is that which shall be; and that which is done is that which shall be done; and there is no new thing under the sun. Is there anything whereof it may be said, See, this is new? It hath been already of old time, which was before us."

Other references to evolutionary views in one form or another occur in the writings of several philosophers of classic times, as you have had recent cause to remember.

Whether these are to be considered as an expression of a perfect truth in the very imperfect language which was alone intelligible to the nation to whom this sacred book was immediately addressed on the one hand; and the happy guesses of philosophers, who by deep intuition had placed themselves in close sympathy with the material universe, on the other hand, I shall not stop to enquire. The discussion would be profitless, for modern science in no way depends for its magnificent triumphs of fact and thought upon any utterances of the ancients. It is the creation of patient intelligent labor of the last two centuries, and its results can be neither confuted nor confirmed by anything that was said, thought or done at an earlier period. I have merely referred to these indications of doctrines of evolution to recall to your minds that the two great schools of thought, which now divide philosophers, have existed from very remote times. They are,

[1] Proceedings Am. Assoc. Adv. Sc. xxi (Portland).

therefore, in their origin, probably independent of correct scientific knowledge.

You have learned from the geologists, and mostly from those of the present century, that the strata of the earth have been successively formed from fragments more or less comminuted by mechanical action, more or less altered by chemical combination and molecular rearrangement. These fragments were derived from strata previously deposited, or from material brought up from below, or even thrown down from above, or from the débris of organic beings which extracted their mineral constituents from surrounding media. Nothing new has been added, everything is old: only the arrangement of the parts is new, but in this arrangement definite and recognizable unchanged fragments of the old frequently remain. Geological observation is now so extended and accurate that an experienced student can tell from what formation, and even from what particular locality these fragments have been derived.

I wish to show that this same process has taken place in the organic world, and that by proper methods we can discover in our fauna and flora the remnants of the inhabitants of former geologic times, which remain unchanged, and have escaped those influences of variation which are supposed to account for the differences in the organic beings of different periods.

Should I succeed in this effort, we will be hereafter enabled in groups of animals which are rarely preserved in fossil condition, to reconstruct, in some measure, the otherwise extinct faunæ, and thus to have a better idea of the sequence of generic forms in time. We will also have confirmatory evidence of certain changes which have taken place in the outline of the land and the sea. More important still, we will have some indications of the time when greater changes have occurred, the rock evidence of which is now buried at the bottom of the ocean, or perhaps entirely destroyed by erosion and separations. Of these changes, which involved connections of masses of land, no surmise could be made, except through evidence to be gained in the manner of which I am about to speak.

My illustrations will naturally be drawn from that branch of zoology, with which I am most familiar; and it is indeed to your too partial estimate of my studies in that science, that I owe the privilege of addressing you on the present occasion.

There are, as you know, a particular set of Coleoptera which affect the seashore; they are not very numerous at any locality, but among them are genera which are represented in almost every country of the globe. Such genera are called cosmopolitan, in distinction to those which are found only in particular districts. Several of these genera contain species which are very nearly allied, or sometimes in fact undistinguishable and therefore identical along extended lines of coast.

Now it happens that some of these species, though they never stray from the ocean shore inland, are capable of living upon similar beaches on fresh water lakes, and a few are found in localities which are now quite inland.

To take an example, or rather several examples together, for the force of the illustration will be thereby greatly increased.

Along the whole of the Atlantic, and the greater part of the Pacific coast of the United States, is found in great abundance on sand beaches, a species of Tiger-beetle, *Cicindela hirticollis*, an active, winged and highly predaceous insect; the same species occurs on the sand beaches of the great lakes, and were it confined to these and similar localities, we would be justified in considering it as living there in consequence solely of the resemblance in the conditions of existence. But, it is also found, though in much less abundance, in the now elevated region midway between the Mississippi and Rocky Mountains. Now, this is the part of the continent which, after the division of the great intercontinental gulf in Cretaceous times, finally emerged from the bed of the sea, and was in the early and middle Tertiary converted into a series of immense fresh water lakes. As this insect does not occur in the territory extending from the Atlantic to beyond the western boundary of Missouri, nor in the interior of Oregon and California, I think that we should infer that it is an unchanged survivor of the species which lived on the shores of the Cretaceous ocean, when the intercontinental gulf was still open, and a passage existed, moreover, towards the south-west, which connected with the Pacific.

The example I have given you of the geographical distribution of *Cicindela hirticollis* would be of small value, were it an isolated case; nor would I have thought it worthy of occupying your time, on an occasion like this, which is justly regarded as one for the communication of important truth. This insect, which I have selected as a type for illustrating the methods of investigation to

which I invite your attention, is, however, accompanied more or less closely by other Coleoptera, which like itself are not particular as to the nature of their food, so long as it be other living insects, and apparently are equally indifferent to the presence of large bodies of salt water. First, there is *Cicindela lepida*, first collected by my father, near Trenton, New Jersey, afterwards found on Coney Island, near New York, and received by me from Kansas and Wisconsin; not, however, found west of the Rocky Mountains. This species, thus occurring in isolated and distant localities, is probably in process of extinction, and may or may not be older than *C. hirticollis*. I am disposed to believe, as no representative species occurs on the Pacific coast, and from its peculiar distribution, that it is older. Second, there is *Dyschirius pallipennis*, a small Carabide, remarkable among other species of the genus by the pale wing covers, usually ornamented with a dark spot. This insect is abundant on the Atlantic coast from New York to Virginia, unchanged in the interior parts of the Mississippi valley, represented at Atlantic City, New Jersey, by a larger and quite distinct specific form, *C. sellatus*, and on the Pacific coast by two or three species of larger size and different shape, which in my less experienced youth I was disposed to regard as a separate genus *Akephorus*. This form is, therefore, in a condition of evolution,—how, I know not,—our descendants may. The Atlantic species are winged, the Pacific ones, like a large number of insects of that region are without wings.

Accompanying these are Coleoptera of other families, which have been less carefully studied, but I will not trespass upon your patience by mentioning more than two. *Bledius pallipennis* (*Staphylinidæ*) is found on salt marshes near New York, on the Southern sea coast, and in Kansas,—*Ammodonus fossor*, a wingless Tenebrionide, Trenton, seashore near New York, and valley of Mississippi at St. Louis; thus nearly approximating *Cicindela lepida* in distribution.

We can thus obtain by a careful observation of the localities of insects, especially such as affect seashore or marsh, and those which being deprived of their favorite surroundings, have shown, if I may so express myself, a patriotic clinging to their native soil, most valuable indications in regard to the time at which their unmodified ancestors first appeared upon the earth. For it is obvious that no tendency to change in different directions by "nu-

merous successive slight modifications"[1] would produce a uniform result in such distant localities, and under such varied conditions of life. Properly studied, these indications are quite as certain as though we found the well preserved remains of these ancestors in the mud and sand strata upon which they flitted or dug in quest of food.

Other illustrations of survivals from indefinitely more remote times I will also give you, from the Coleopterous fauna of our own country, though passing time admonishes me to restrict their number.

To make my remarks intelligible, I must begin by saying that there are three great divisions of Coleoptera, which I will name in the order of their complication of structural plan: 1. Rhynchophora; 2. Heteromera; 3. Ordinary or normal Coleoptera; the last two being more nearly allied to each other than either is to the first. I have in other places exposed the characters of these divisions, and will not detain you by repeating them.

From Palæontological evidence derived from other branches of zoology, we have a right to suppose, if this classification be correct, that these great types have been introduced upon the earth in the order in which I have named them.

Now, it is precisely in the first and second series that the most anomalous instances of geographical distribution occur; that is to say, the same or nearly identical genera are represented by species in very widely separated regions, without occurring in intermediate or contiguous regions. Thus there is a genus *Emeax*, founded by Mr. Pascoe, upon an Australian species, which, when I saw it, I recognized as belonging to *Nyctoporis*, a California genus, established many years before; and in fact barely specifically distinct from *N. galeata*. Two other examples are *Othnius* and *Eupleurida*, United States genera, which are respectively equivalent to *Elacatis* and *Ischalia*, found in Borneo. Our native genera *Eurygenius* and *Toposcopus*, are represented by scarcely different forms in Australia. All these belong to the second series (*Heteromera*), and the number of examples might be greatly increased with less labor on my part than patience on yours.

A single example from the Rhynchophora, and I will pass to another subject.

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[1] Origin of Species, 1869, 227.

On the sea coast of California, extending to Alaska, is a very anomalous insect, whose affinities are difficult to discern, called *Emphyastes fucicola*, from its occurrence under the sea-weed cast up by the waves. It is represented in Australia by several species of a nearly allied genus Aphela, found in similar situations.

In all entomological investigations relating to geographical distribution, we are greatly embarrassed by the multitude of species, and by the vague and opinionative genera founded upon characters of small importance. The Coleoptera alone, thus far described, amount to over 60,000 so-called species, and there are from 80,000 to 100,000 in collections. Under these circumstances it is quite impossible for one person to command either the time or the material to master the whole subject, and from the laudable zeal of collectors to make known what they suppose to be new objects, an immense amount of synonymy must result. Thus in the great Catalogus Coleopterorum of Gemminger and Harold, a permanent record of the untiring industry of those two excellent entomologists, species of the genus *Trechicus* founded by me upon a small North American insect, are mentioned under five generic names, only one of which is recognized as a synonym of another. These generic headings appear in such remote pages of the volume as 135, 146 and 289.

The two closely allied genera of Rhynchophora mentioned above are separated by no less than 168 pages.

It is therefore plain, that before much progress can be made in the line of research which I have proposed to you, whereby we may recover important fragments of the past history of the earth, Entomology must be studied in a somewhat different manner from that now adopted. The necessity is every day more apparent that descriptions of heterogeneous material are rather obstructive than beneficial to science, except in the case of extraordinary forms likely to give information concerning geographical distribution or classification. Large typical collections affording abundant material for comparison, for the approximation of allied forms, and the elimination of doubtful ones must be accumulated; and in the case of such perishable objects, as those we are now dealing with, must be placed where they can have the protecting influences both of climate and personal care.

At the same time, for this investigation, the study of insects is peculiarly suitable; not only on account of the small size, ease of collecting, and little cost of preserving the specimens, but because

from their varied mode of life in different stages of development, and perhaps for other reasons, the species are less likely to be destroyed in the progress of geological changes.[1] Cataclysms and submergences, which would annihilate the higher animals, would only float the temporarily asphyxiated insect, or the tree trunks containing the larvæ and pupæ to other neighboring lands. However that may be, I have given you some grounds for believing, that many of the species of insects now living existed in the same form before the appearance of any living genera of mammals, and we may suppose that their unchanged descendants will probably survive the present mammalian fauna, including our own race.

I may add, moreover, that some groups, especially in the Rhynchophora, which, as I have said above, I believe to be the earliest introduced of the Coleoptera, exhibit with compact and definite limits, and clearly defined specific characters, so many generic modifications, that I am compelled to think that we have in them an example of the long sought unbroken series, extending in this instance from early mesozoic to the present time, and of which very few forms have become extinct.

I have used the word *species* so often, that you will doubtless be inclined to ask, what, then, is understood by a species? Alas! I can tell you no more than has been told recently by many others. It is an assemblage of individuals, which differ from each other by very small or trifling and inconstant characters, of much less value than those in which they differ from any other assemblage of individuals. Who determines the value of these characters? The experienced student of that department to which the objects belong. Species are, therefore, those groups of individuals representing organic forms which ARE RECOGNIZED as such by those who from natural power and education are best qualified to judge.

You perceive, therefore, that we are here dealing with an entirely different kind of information from that which we gain from the physical sciences; everything there depends on accurate observation, with strict logical consequences derived therefrom. Here the basis of our knowledge depends equally on accurate and trained observation, but the logic is not formal but perceptive.

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[1] For a fuller discussion of these causes, and of several other subjects which are briefly mentioned in this address, the reader may consult an excellent memoir by my learned friend, Mr. Andrew Murray, "On the Geographical Relations of the Chief Coleopterous Faunæ." (Journal of Linnæan Society, Zoology, Vol. xi.)

This has been already thoroughly recognized by Huxley[1] and Helmholtz,[2] and others, but we may properly extend the inquiry into the nature and powers of this æsthetic perception somewhat farther. For it is to this fundamental difference between biological and physical sciences that I will especially invite your attention.

Sir John Lubbock,[3] quoting from Oldfield[4] mentions that certain Australians "were quite unable to realize the most vivid artistic representations. On being shown a picture of one of themselves, one said it was a ship, another a kangaroo, not one in a dozen identifying the portrait as having any connection with himself."

These human beings, therefore, with brains very similar to our own, and as is held by some persons, potentially capable of similar cultivation with ourselves, were unable to recognize the outlines of even such familiar objects as the features of their own race. Was there any fault in the drawing of the artist? Probably not. Or in the eye of the savage? Certainly not, for that is an optical instrument of tolerably simple structure, which cannot fail to form on the retina an accurate image of the object to which it is directed. Where then is the error? It is in the want of capacity of the brain of the individual (or rather the race in this instance) to appreciate the resemblance between the outline, the relief, the light and shade of the object pictured, and the flat representation in color: in other words, a want of "artistic tact" or æsthetic perception.

A higher example of a similar phenomenon I have myself seen: many of you too have witnessed it, for it is of daily occurrence. It is when travellers in Italy having penetrated to the inmost chamber of the Temple of Art, even the Hall of the Tribune at Florence, stand in presence of the most perfect works of Art, which it has been given to man to produce, and gaze upon them with the same

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[1] "A species is the smallest group to which distinctive and invariable characters can be assigned." (Principles and Methods of Palæontology, Smithsonian Report, 1869, 378).

[2] "I do not mean to deny that, in many branches of these sciences, an intuitive perception of analogies and a certain artistic tact play a conspicuous part. In natural history . . . . . it is left entirely to this tact, without a clearly definable rule, to determine what characteristics of species are important or unimportant for purposes of classification, and what divisions of the animal or vegetable kingdom are more natural than others." (Relation of the Physical Sciences to Science in General. Smiths. Report, 1871, 227.)

[3] Prehistoric Times, p. 440.

[4] On the Aborigines of Australia. Trans. Ethnological Soc. New Series, Vol. 3.

indifference that they would show to the conceptions of mediocre artists exhibited in our shops.

Perhaps they would even wonder what one can find to admire in the unrivalled collection, which is there assembled.

There is surely wanting in the minds of such persons that high, æsthetic sense, which enables others to enter into spiritual harmony with the great artists whose creations are before them.

Creations I said, and I use the word intentionally. If there is one power of the human soul, which more nearly than any other approaches the faculty of creation, it is that by which the almost inspired artist develops out of a rude block of stone, or out of such mean materials as canvass and metallic pastes of various colors, figures which surpass in beauty, and in power of exciting emotion, the objects they profess to represent.

Yet these unæsthetic and nonappreciative persons are just as highly educated, and in their respective positions as good and useful members of the social organism as any that may be found. I maintain only, they would never make good students of biology.

In like manner, by way of illustrating the foregoing observations, there are some, who in looking at the phenomena of the external Universe, may recognize only Chance, or the "fortuitous concourse of atoms," producing certain resultant motions. Others, having studied more deeply the nature of things, will perceive the existence of laws, binding and correlating the events they observe. Others again, not superior to the latter in intelligence, nor in power of investigation, may discern a deeper relation between these phenomena, and the indications of an intellectual or æsthetic or moral plan, similar to that which influences their own actions, when directed to the attaining of a particular result.

These last will recognize in the operations of nature the direction of a Human Intelligence, greatly enlarged, capable of modifying at its will influences beyond our control; or they will appreciate in themselves a resemblance to a superhuman intelligence which enables them to be in sympathy with its actions.

Either may be true in individual instances of this class of minds; one or other must be true; I care not which, for to me the propositions are in this argument identical, though in speculative discussions, they may be regarded as at almost the opposite poles of religious belief. All that I plead for is, that those who have not this perceptive power, and who in the present condition of

scientific discussion are numerically influential, will have tolerance for those who possess it; and that the ideas of the latter may not be entirely relegated to the domain of superstition and enthusiasm.

In the case of the want of perception of the Australian, a very simple test can be applied. It is only to photograph the object represented by the artist, and compare the outlines and shades of the photograph, with those of the picture. If they accord within reasonable limits the picture is correct to that extent; at least, however bad the artist, the human face could never be confounded with a ship, or a kangaroo.

Can we apply a similar test to the works of nature? I think we can. Suppose that man,—I purposely use the singular noun to indicate that all human beings of similar intelligence and education working towards a definite end, will work in a somewhat similar manner,—suppose, then I say, that man, endeavoring to carry out some object of importance, devises a method of so doing, and creates for that purpose a series of small objects, and we find that these small objects naturally divide and distribute themselves in age and locality, in a similar manner to that in which the species of a group of organisms are divided in space, and distributed in time; and that the results of man's labor are thus divided and distributed on account of the necessary inherent qualities of his intelligence and methods of action, is not the resemblance between human reason and the greater powers which control the manifestations of organic nature apparent?

I now simply present to you this investigation. Time is wanting for me to illustrate it by even a single example, but I feel sure that I have in the minds of some of you already suggested several applications of it to the principle I wish to teach:—the resemblance in the distribution of the works of nature to that of human contrivances evolved for definite purposes.

If this kind of reasoning commends itself to you, and you thus perceive resemblances in the actions of the Ruler of the Universe to those of our own race, when prompted by the best and highest intellectual motives, you will be willing to accept the declaration of the ancient text, "He doeth not evil, and abideth not with the evil inclined. Whatever he hath done is good;"[1] or that

[1] Desatir, p. 2.

from our own canon of Scripture: "With him is wisdom and strength, he hath counsel and understanding."[1]

The æsthetic character of Natural History, therefore, prevents the results of its cultivation from being worked out with the precision of a logical machine, such as with correct data of observation and calculation would be quite sufficient to formulate the conclusions of physical investigation. According as the perception of the relations of organic beings among themselves becomes more and more enlarged, the interpretation of these relations will vary within limits; but we will be continually approximating higher mental or spiritual truth.

This kind of truth can never be revealed to us by the study of inorganic aggregations of the universe. The molar, molecular and polar forces, by which they are formed, may be expressed, so far as science has reduced them to order, by a small number of simply formulated laws, indicative neither of purpose nor intelligence, when confined within inorganic limits. In fact, taking also the organic world into consideration, we as yet see no reason why the number of chemical elements known to us should be as large as it is, and go on increasing almost yearly with more minute investigations. To all appearance, the mechanical and vital structure of the universe would remain unchanged, if half of them were struck out of existence.

Neither is there any evidence of intelligence or design in the fact that the side of the moon visible to us exhibits only a mass of volcanoes.

Yet upon the earth, without the volcano and the earthquake, and the elevating forces of which they are the feeble indications, there would be no permanent separation of land and water; consequently no progress in animal and vegetable life beyond what is possible in the ocean. To us, then, as sentient beings, the volcano and the earthquake, viewed from a biological standpoint, have a profound significance.

It is indeed difficult to see in what manner the student of purely physical science is brought to a knowledge of any evidences of intelligence in the arrangement of the Universe. The poet, inspired by meditating on the immeasurable abyss of space, and the transcendent glories of the celestial orbs has declared,

"The undevout astronomer is mad,"

[1] Job, xii, 13.

and his saying had a certain amount of speciousness, on account of the magnitude of the bodies and distances with which the student of the stars is concerned. This favorite line is, however, only an example of what an excellent writer has termed "the unconscious action of volition upon credence," and it is properly in the correlations of the inorganic with the organic world, that we may hope to exhibit, with clearness, the adaptations of plan prefigured and design executed.

In the methods and results of investigation, the mathematician differs from both the physicist and the biologist. Unconfined like the former, by the few simple relations by which movements in the inorganic world are controlled, he may not only vary the form of his analysis, almost at pleasure, making it more or less transcendental in many directions, but he may introduce factors or relations, apparently inconceivable in real existences, and then interpret them into results quite as real as those of the legitimate calculus with which he is working, but lying outside of its domain.

If biology can ever be developed in such manner that its results may be expressed in mathematical formulæ, it will be the pleasing task of the future analyst, to ascertain the nature of the inconceivable (or imaginary as they are termed in mathematics) quantities which must be introduced when changes of form or structure take place. Such will be analytical morphology, in its proper sense; but it is a science of the future, and will require for its calculus a very complex algebra.

In the observation of the habits of inferior animals, we recognize many complications of action, which though directed to the accomplishment of definite purposes, we do not entirely comprehend. They are, in many instances, not the result of either the experience of the individual, or the education of its parents, who in low forms of animals frequently die before the hatching of the offspring. These actions have been grouped together, whether simple or complex, as directed by what we are pleased to call instinct, as opposed to reason. Yet there is every gradation between the two.

Among the various races of dogs, the companions of man for unnumbered centuries, we observe not only reasoning powers of a rather high order, but also distinct traces of moral sentiments, similar to those possessed by our own race. I will give no examples, for many may be found in books with which you are familiar.

Actions evincing the same mental attributes are also noticed in wild animals, which have been tamed. You will reply, that these qualities have been developed by human education; but not so, there must have been a latent capacity in the brain to receive the education, and to manifest the results by the modification of the habits. Now it is because we are vertebrates, and the animals of which I have spoken are vertebrates, that we understand, though imperfectly, their mental processes, and can develop the powers that are otherwise latent. Could we comprehend them more fully we would find, and we do find from time to time in the progress of our inquiries, that what was classed with instinct is really intellection.

When we attempt to observe animals belonging to another subkingdom, Articulata, for instance, such as bees, ants, termites, etc., which are built upon a totally different plan of structure, having no organ in common with ourselves, the difficulty of interpreting their intellectual processes, if they perform any, is still greater. The purposes of their actions we can only divine by their results. But anything more exact than their knowledge of the objects within their scope, more ingenious than their methods for using those objects, more complex, yet well devised than their social and political systems, it is impossible to conceive.

We are not warranted in assuming that these actions are instinctive, which if performed by a vertebrate we would call rational. Instead of concealing our ignorance under a word which thus used, comes to mean nothing, let us rather admit the existence here of a rational power, not only inferior to ours, but also different.

Thus proceeding, from the highest forms in each type of animal life to the lower, and even down to the lowest, we may be prepared to advance the thesis, that all animals are intelligent, in proportion to the ability of their organization to manifest intelligence to us, or to each other; that wherever there is voluntary motion, there is intelligence:— obscure it may be, not comprehended by us, but comprehended by the companions of the same low grade of structure.

However this may be, I do not intend to discuss the subject at present, but only wish in connection with this train of thought to offer two suggestions.

The first is, that by pursuing different courses of investigation in biology, we may be led to opposite results. Commencing with

the simplest forms of animal life, or with the embryo of the higher animals, it may be very difficult to say at what point intelligence begins to manifest itself; our attention is concentrated, therefore, upon those functions which appear to be the result of purely mechanical arrangements, acted upon by external stimuli. The animal becomes to our perception an automaton, and in fact, by excising some of the nervous organs last developed in its growth, we can render an adult animal an automaton, capable of performing only those habitual actions to which its brain, when in perfect condition, had educated the muscles of voluntary motion. On the other hand, commencing with the highest group in each type, and going downwards, either in structural complication, or in age of individual, it is impossible to fix the limit at which intelligence ceases to be apparent.

I have in this subject, as in that of tracing the past history of our insects, in the first part of this address, preferred the latter mode of investigation; taking those things which are nearest to us in time or structure, as a basis for the study of those more remote.

The second consideration is, since it is so difficult for us to understand the mental processes, whether rational or instinctive (I care not by what name they are called), of beings more or less similar, but inferior to ourselves; we should exercise great caution when we have occasion to speak of the designs of One who is infinitely greater. Let us give no place to the crude speculations of would-be-teleologists, who are indeed, in great part refuted already by the progress of science, which continually exhibits to us higher and more beautiful relations between the phenomenon of Nature "than it hath entered into the mind of man to conceive." Let not our vanity lead us to believe that because God has deigned to guide our steps a few paces on the road of truth, we are justified in speaking as if He had taken us into intimate companionship, and informed us of all His counsels.

If I have exposed my views on these subjects to you in an acceptable manner, you will perceive that in minds capable of receiving such impressions, biology can indicate the existence of a creative or directive power, possessing attributes, some of which resemble our own, and controlling operations which we may feebly comprehend. Thus far Natural Theology, and no farther.

What then is the strict relation of Natural History or biology to that great mass of learning and influence which is commonly

called Theology; and to that smaller mass of belief and action which is called Religion?

Some express the relation very briefly, by saying that Science and Religion are opposed to each other. Others again that they have nothing in common. These expressions are true of certain classes of minds; but the greater number of thinking and educated persons see, that though the ultimate truths taught by each are of quite distinct nature, and can by no means come in conflict, inasmuch as they have no point in common; yet so far as these truths are embodied in human language, and manipulated by human interests, they have a common dominion over the soul of man. According to the method of their government, they may then come into collision even as the temporal and spiritual sovereigns of Japan occasionally did, before the recent changes in that country.

In answering the query above proposed, it will be necessary to separate the essential truths of religion from the accessories of tradition, usage, and most of all, organizations and interpretations, which have in the lapse of time gathered around the primitive or revealed truth.

With the latter, the scientific man must deal exactly like other men, he must take it, or reject it, according to his spiritual gifts; but he must not, whatever be his personal views, discuss it or assail it *as a man of science*, for within his domain of investigation it does not belong.

With regard to the accessories of traditions, interpretations, etc., our answer may be clearer, when we have briefly reviewed some recent events in what has been written about as the Conflict of Religion and Science. Some centuries ago, great theological disgust was produced by the announcement that the sun and not the earth was the centre of the planetary system. A few decades ago profound dissatisfaction was shown that the evidence of organic life on the planet was very ancient. Recently some annoyance has been exhibited because human remains have been found in situations where they ought not to have been, according to popularly received interpretations; and yet more recently much apprehension has been felt at the possible derivation of man from some inferior organism; an hypothesis framed simply because in the present condition of intellectual advancement, no other can be suggested.

Yet all these facts, but the last, which still is an opinion, have been accepted, after more or less bitter controversy on both sides, and the fountain of spiritual truth remains unclouded and undiminished. New interpretations for the sacred texts, supposed to be in conflict with the scientific facts, have been sought and found without difficulty. These much feared facts have, moreover, given some of the strongest and most convincing illustrations to modern exhortation and religious instruction.

Thus, then, we see that the influence of Science upon Religion, has been beneficial. Scholastic interpretations founded upon imperfect knowledge, or no knowledge, but mere guess, have been replaced by sound criticism of the texts, and their exegesis in accordance with the times and circumstances for which they were written.

It must be conceded by fair minded men of both sides that these controversies were carried on at times with a rudeness of expression and bitterness of feeling now abhorrent to our usages. The intellectual wars of those days partook of the brutality of physical war, and the horrors of the latter, as you know, have been ameliorated only within very few years.

I fear that the unhappy spirit of contention still survives, and that there are yet a few who fight for victory rather than for truth. The deceptive spirit of Voltaire still buds forth occasionally; he, who, as you remember, disputed the organic nature of fossil shells, because in those days of schoolmen, their occurrence on mountains would be used by others as a proof of a universal Noachian deluge. The power of such spirits is fortunately gone for any potent influence for evil, gone with the equally obstructive influence of the scholastics with whom they formerly contended.

Since then, there is no occasion for strict Science and pure Religion to be in conflict, how shall the peace be kept between them?

By Toleration and Patience. Toleration towards those who believe less than we do, in the hope that they, by cultivation or inheritance of æsthetic perception, will be prepared to accept something more than Matter and Energy in the Universe, and to believe that Vitality is not altogether undirected Colloid Chemistry.

Toleration also towards those who, on what we think misunderstood or insufficient evidence, demand more than we are prepared to admit, in the hope that they will revise additional texts which

seem to conflict, or may hereafter conflict with facts deduced from actual study of Nature, and thus prepare their minds for the reception of such truths as may be discovered, without embittered discussions.

Patience, too, must be counselled. For much delay will ensue before this desired result is arrived at; patience under attack, patience under misrepresentation, but never controversy.

Thus will be hastened the time, when the glorious, all sufficient spiritual light, which though given through another race, we have adopted as our own, shall shine with its pristine purity, freed from the incrustations with which it has been obscured by the vanity of partial knowledge, and the temporary contrivances of human polity.

So, too, by freely extended scientific culture, may we hope that the infinitely thicker and grosser superstitions and corruptions will be removed, which greater age and more despostic governments have accumulated around the less brilliant, though important religions of our Asiatic Aryan relatives. These accretions being destroyed, the principal difficulty to the reception by those nations of higher spiritual truths will be obviated, and the intelligent Hindoo or Persian will not be tardy in recognizing in the pure life and elevated doctrine of the sincere Christian, an addition to, and fuller expression of religious precepts with which he is familiar. In this manner alone may be realized the hope of the philosopher, the dream of the poet, and the expectation of the theologian. A Universal Science, and a Universal Religion, coöperating harmoniously for the perfection of man and the glory of his Creator.

THE CROCODILE IN FLORIDA.

BY WM. T. HORNADAY.

In the warm, placid waters of tropical streams whose banks are bordered by reedy marshes and forests of perpetual green, is the home of the crocodile. About the middle of the day numbers may be seen lying lazily on the banks enjoying the heat, their polished scales shining in the sunlight, and all looking the very picture of tropical languor and repose. Its daily food is the